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RADIOASTRONOMICAL INVESTIGATIONS OF THE SMALL-SCALE SPATIAL INHOMOGENEITIES' MOTIONS AND DIMENSIONS

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SUMMARY

This work describes the use of a radioastronomical method as means of solar wind measurements. It has the advantage over standard rocket methods in that it allows to obtain the characteristics of the inhomogenous electron component. After unambiguous determination of the diffraction pattern of linear dimensions, it becomes possible to derive the electron concentration.

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The investigations of rapid intensity variations (scintillations) of radio emission from sources with small angular dimension [1,2], conducted since 1965 at the Radioastronomical Laboratory of the Lebedev Institute of Physics, were the object of further development. The scintillations are registered simultaneously at several points, removed from each other at specific distances. If the investigations at one point permitted to obtain only the measure and the scintillation-period, several ones make it possible to determine independently the dimension and the direction of motion velocity of the diffraction pattern (consequently also of plasma inhomogeneity), as well as the characteristic dimensions, shape and orientation of inhomogeneities.

At present there are data on several methods of solar wind measurement. However, radioastronomical investigations do not simply complement the possibilities of these methods, but have difference of principle. In particular, only the proton component of solar wind is measured with rocket aid, but with the radioastronomical method we obtain the motion characteristics of the inhomogenous electron-component. Besides, contrary to rocket measurements, the radioastronomical method is used in the investigation of very close to rather remote distances from the Sun.

The setup of the mentioned investigations is discussed in the work [3].* The points of observation are located at the summits of an approximately equilateral triangle with 220 km sides. A cross-shaped range radiotelescope in the City of Puschino is used for a receiving antenna at one of the points. Two other radiotelescopes with effective antenna area of about 1000 M^2 each are situated in the region of the cities of Kalinin and Pereslavl'-Zalesskiy. The registration is made simultaneously at all the points. The synchronization in time is materialized by means of continuous registration of exact-time signals on the tape.

The first observation of scintillations at the three points, were conducted by us simultanously in September 1966 [4]. Continuous observations of sources ES-48, ES-144, ES-147 and others have been conducted since March 1967. The similarity method is used for processing. Only the very distinct similar portions of curves obtained at the three points are processed. Determined by the characteristic points on these curves, for example, by the maxima and minima of the amplitude fluctuations are the relative temporal shifts. The directions and magnitudes of diffraction pattern velocities relative to observation points are determined by the well known geometry of points, and the obtained values of temporal shifts. The results presented herewith are derived from daily observations of the source ES-48, in the first half of the year 1967.

The average of a day's observation of velocity vectors is shown in Fig.I. The visible position of the source in the celestial sphere relative to the Sun varies from one day to another; a) is a phase of rapprochement between the discrete source and the Sun, b) is a phase of recession. It is obvious that the mean received motion directions are close to the radial toward the side of the Sun with velocity magnitudes $\sim$ 200-300 km/sec.

The dependence of velocity direction on the distance to the Sun, may be seen in Fig. 2, where the deflection $\Delta\Theta$ is shown for sevral positions of the source. Marked by circles are the mean values $\Delta\Theta$ for the values $\Theta > 25°$ and $\Theta < 25°$ respectively. In the first case $\Delta\Theta = 14 \pm 3°$, in the second $\Delta\Theta = 15 \pm 7°$. Thus we observe at greater distances a deflection of the direction of motion toward the equatorial region and at small distances (polar regions) from the radial direction to the side of the Sun's line of the pole.

A histogram of diffraction pattern velocities is presented

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* A detailed method and the instrumentation will be described in the works of the Institute of Physics in the name of P.N. Lebedev, AN SSSR

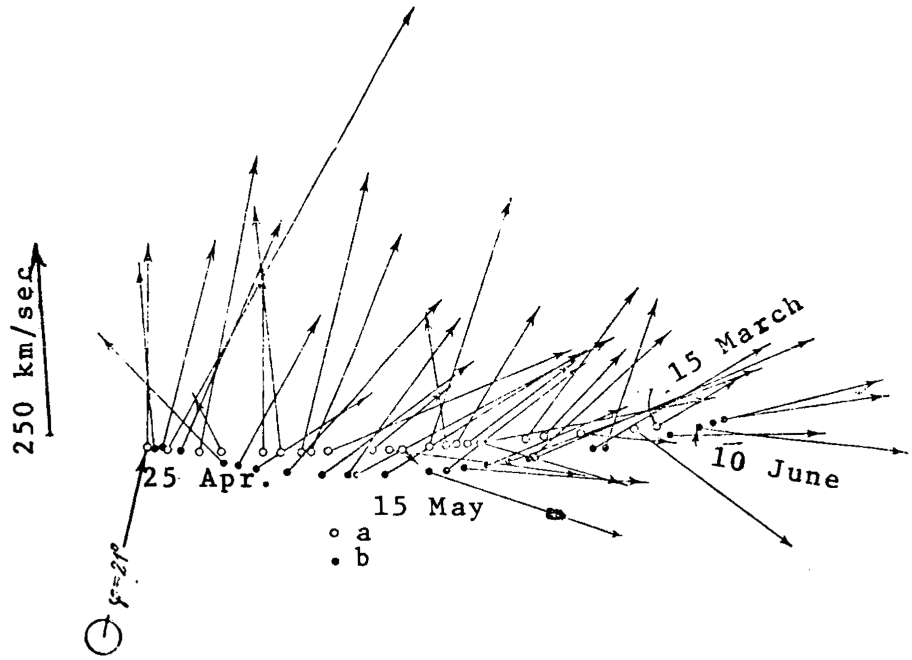

Fig. I. Values of velocity vectors of the diffraction pattern during various days of observations (from 15 March to 15 June 1967). This correlates with the inhomogeneities' velocities at various distances from the Sun. The source is ES-48, λ 3,5 m. a) is a phase of the source-Sun rapprochement; b) is a phase of recession; $\phi = 21°$ is the minimum angular distance of the source from the Sun. Each vector is average of a single day's data.

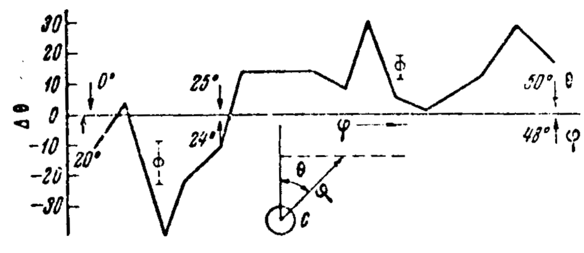

Fig.2.

Value of the deflection angle from radial direction of motion for various distances ϕ from the Sun. The source is ES-48, λ 3,5 m. 1967. + $\Delta\Theta$ are the deflections toward the equatorial plane and - $\Delta\Theta$ is the deflection toward the line of the pole.

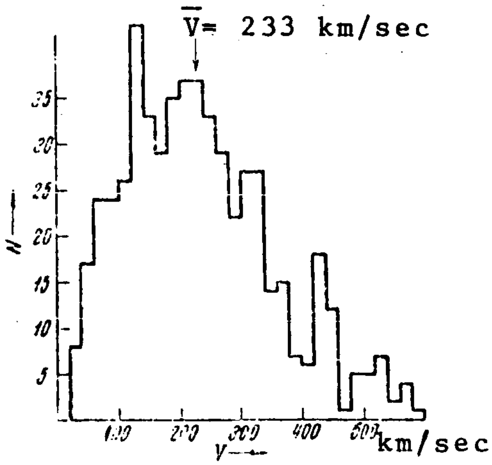

Fig.3

Histogram of measured values of diffraction pattern velocities. ES-48, λ 3,5 m. 1967. V = 233 km/sec is the mean velocity.

in Fig.3. The mean value of measured velocities constitutes 233 km/sec. However, it should be noted that the measured velocity and direction of the diffraction pattern is rectilinear and perpendicular to the direction of motion. If the angle between them constitutes ψ_1, it is not the true velocity V_0 of the diffraction pattern that is measured, but the velocity $V = V_0 \cos \psi_1$, i.e. on account of the mentioned effect, the measured values of velocities are on the average lower than the true ones. The same circumstance leads to the dispersion increase of measured directions of motions. While determining the motion velocity of inhomogeneities, the fact should be taken into account that for inhomogeneities not lying in the plane perpendicular to the line of sight, the measured velocity values are also smaller than the true ones, which could be taken into account by the introduction of the effective angle ψ_2. The expression for a true velocity value V_t of such inhomogeneities taking into account the mentioned effects has the form

$$V_t = V/\cos \psi_1 \cos \psi_2 . \qquad (1)$$

For our observation conditions $\cos \psi_1 \cos \psi_2 \approx 0.7 - 0.8$, and, consequently, the mean values of inhomogeneities' velocity is 280 - 300 km/sec.

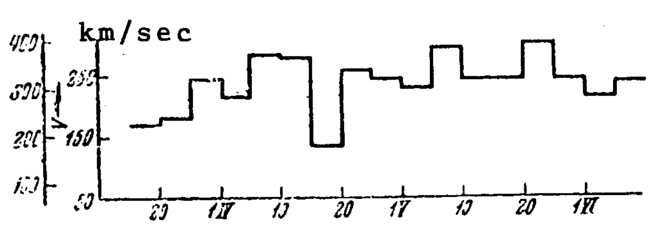

Fig.4

Velocity dependence on observation dates (on angular distance source-Sun). λ 3,5 m. 1967. V is measured diffraction pattern of velocity; V_t is velocity of inhomogeneities. Average for 5 days ($- 65° < \Delta\Theta < + 65°$)

It was noted in the works [4,5] that with the decrease of visible distance of the source from the Sun, increase of solar wind velocity is observed. However, according to our data of this series of observation, as is shown in Fig.4, there is no reliable dependence of this sort. Some velocity increase is observed at the rapprochement of the source with the Sun, but in the second phase (source recession) such dependence is not manifest. The velocity decrease in the nearest region to the Sun, is seen in the same figure.

The linear dimensions of the diffraction pattern are determined unambigously on the basis of the obtained results, (the mean distance L between maxima and minima) and so are the dimensions of inhomogeneities. The mean value of $L = V_t$ is 980 km. This correlates with the inhomogeneities' dimension ($2_a = L/2.6$) of approximately 380 km. Now it is possible to find electron concentrations (or to be more precise, their excess over the mean value). Computations of [6] yield the values $\Delta N \sim 2 \cdot 10^{-2}$ for $\phi \sim 40°$.

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* * * THE END * * *

Institute of Physics in
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REFERENCES

1. V.V. VITKEVICH, T.D. ANTONOVA, V.I. VLASOV: DAN,168, No.1, 55, (1966)
2. T.D. ANTONOVA, V.V. VITKEVICH, V.I. VLASOV: Tr. Fiz. Inst. Im. P.N. Lebedeva AN SSSR, 38, 88, (1967)
3. V.V. BITKEVICH; Tr. Fiz. Inst. Im.P.N.Lebedeva AN SSSR, 38, 80, (1967)
4. V.V. VITKEVICH, V.I. VLASOV: Astronom. Circ. No.396 (1966)
5. A. HEWISH, P. DENNISON: Nature, 213, No.5074, (1967)
6. T.D. ANTONOVA, V.V. VITKEVICH: Astronom Circular (in print).

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